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THE INSTRUCTIONAL EFFECTIVENESS OF COLOR IN TELEVISION--A REVIEW OF THE EVIDENCE. USING EDUCATIONAL MEDIA--GUIDES TO THE LITERATURE, SERIES 1.

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THIS DOCUMENT REVIEWS A NUMBER OF STUDIES CONDUCTED TO DETERMINE THE EFFECT OF COLOR IN TELEVISION ON HUMAN LEARNING, AS MEASURED BY OBJECTIVE TESTS. THE FINDINGS REVEAL AN APPARENT LACK OF COLOR EFFECTIVENESS UPON LEARNING. (MS)

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THE INSTRUCTIONAL EFFECTIVENESS OF COLOR IN TELEVISION: A REVIEW OF THE EVIDENCE

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The rapid commercial development of color television, the increased use of color television at home, and the evidence that newer educational television facilities will employ color television stimulate interest in the question: What is the effect, if any, of color upon human learning?

In examining this question certain cautions should be spelled out. The first is the necessity for emphasizing that this discussion will be concerned with human learning as it may be measured by objective tests. I am not concerned with the aesthetic effects of color. It should also be pointed out that, while the literature on color as a subject matter is enormous, when you focus down to the topic of *color and human learning* a scarcity of information is encountered. I have found very few studies on the specific topic, but these few provide information on the interaction between color and human learning.

Color in Visual Displays

One of a number of studies on the use of visual displays, by Sumner (1932) indicates that visibility of numbers and letters printed in various color combinations depends primarily on brightness and contrast, rather than color. A number of studies are reported on the effect of color-coding printed material. For example, in one study by Van Buskirk (1932) involving the serial learning of nonsense syllables, color coding of midposition syllables reduced the effect of inhibition or forgetting of these centrally placed syllables. More recently, a series of studies by Sidney Smith (1963, 1964, 1965) have dealt with the effect of increasing the number of items which are color coded, and the effect of this procedure upon perception and decision making. For other studies of color coding, see Green and Anderson (1956), Conover and Kraft (1958), Jones (1962), and Dyer *et alia* (1965).

A consistent finding is that as the number of color coded items increases, the value of color as a cue for selecting important information decreases. As the total number of items decreases, the

value of color decreases. In other words, in a very dense visual display color coding at some minimal level helps in picking out important information, but if you increase this use of color its value as a selection cue diminishes.

Two major studies of color in training films and instructional television are related to our interests here. The studies are not new, but they are basic to any discussion of the effectiveness of color in learning.

The first of these is titled "Relative Effectiveness of Color and Black and White in Instructional Films" and was conducted by A. W. VanderMeer in June, 1952. In this experiment, color and black and white variations of five instructional films were shown to high school students. Half the students saw color films -- the other half, black and white. They were then tested immediately after the film showings and again six weeks later to see how much they had learned and remembered.

VanderMeer's results did not reveal any differences between color and black and white films in the immediate tests of student learning. He reports, however, that the results did suggest, in retention tests, that color combinations reduced the rate of forgetting.

In a second experiment conducted a year later, VanderMeer essentially repeated the study, using four or five original films, but using a design which attempted to better control differences in "learning characteristics". Once again he obtained the same results in immediate student learning. No retention tests were given.

Attitude questionnaires indicated that students preferred the color versions of films, but that film subject matter affected students' attitudes more than color.

The films used in VanderMeer's studies were concerned with subjects such as map reading, the chemistry of sulphur and its components, and the identification of snakes. In testing student learning, VanderMeer used multiple choice tests as well as tests that consisted entirely of items in which a picture or diagram served as a basis for discrimination.

Following these results, VanderMeer speculated on the ineffective showing of color, particularly in the non-verbal tests. One hypothesis was that the impact of color was so strong as to distract attention from the equally relevant and important learning cues. A second hypothesis was that the color films he used may not have presented the learner with the full range of colors that are associated with the objects shown in the films. For example, only one or two color specimens of each snake were shown in the film "snakes". In reality, snakes of the same species vary rather widely in color. In addition, the test slides used for snake identification were not taken from the film, but from other sources. VanderMeer believes that a degree of negative transfer may have taken place because the test slides were colored differently from the film.

In 1959, my colleagues and I devised a study which would further investigate the contributions of color to learning. The study was instigated by the development of color television in that period and by the belief that the U.S. Army would soon be faced with the decision of whether or not to convert to color television. As we phrased it at that time, "to justify the cost of using color television for training, it would seem reasonable to expect some return in teaching effectiveness and learning not possible with monochrome television".

Two studies were carried out over a one-year period with basically the same design. The major objective of these studies was to compare the teaching effectiveness of color and black-and-white television instruction. Analysis was also made of the effects of trainee aptitude and type of subject matter upon learning. The study design called for the simultaneous presentation of color and black-and-white television instruction to two groups equated for aptitude. Both groups received the same television presentation, except that one saw it over a color receiver and the other over a monochrome receiver. They were then tested immediately after to see how much they had learned. Eleven different subject matters were used. These subject matters were ordinarily taught at Fort Monmouth, New Jersey, where the study was conducted, using various amounts of color in charts, maps or other

training materials. For example, one subject was indeed "introduction to color", and made extensive use of colored photos, charts, and diagrams. Student learning was measured by multiple choice tests, and an effort was made to incorporate color items into the tests. These were items in which color seemed to play a relevant role in understanding or answering the question, for example, one item showed various colored resisters and asked for their value in ohms.

In ten out of eleven comparisons, no significant differences were found between the two groups. An analysis was made of the performance on the color test items and no significant difference was found between the two groups. In the second study the same experimental design was employed. The major difference was the use of 15 different hours of instruction at another Army installation. These 15 hours made greater use of color in their classroom presentation than the 11 previously used. The results of this study confirmed those of the first one; no significant differences were found between groups receiving instruction by color or black and white television

Several other studies support these results.

Zuckerman (1954) studied the factual learning resulting from viewing a training film in color as compared to the factual learning resulting from seeing a black and white film strip composed entirely of scenes from the training film. Subjects were Air Force Pilots. There was no significant difference in the amount of learning achieved by the two groups.

May (1958) compared the learning effect of an excellent Kodachrome color film on osmosis with a rather inferior black and white print of the same film. Subjects were fifth- and ninth-grade students. There were no significant differences, either in learning or interest, among the groups that saw the different versions.

Link (1961) showed one group of ninth-grade students in Toronto four films in color, another group the same films in black and white, and a third group both the color and the black and white films. The color films were projected on a screen; the black and white ones were seen

over closed-circuit television. There were no significant differences in learning between the group that saw the color and the one that viewed the films in black and white, but the group that saw both versions learned significantly more than either of the other groups.

Why These Results?

I have found that many people have difficulty accepting the results of these various studies. There is simple disbelief of the finding that color does not appear to provide any important benefits or cues to learning not found in black and white presentations. There is much speculation why this may be so. I think I should reemphasize at this point that these studies are not concerned with the aesthetic effects of color. The pleasure or satisfaction one may obtain by looking at a work of art or a color motion picture is not in dispute or in conflict with the results of these studies. The focus is on human learning.

The question is how to explain an apparent lack of color effectiveness upon learning. I have indicated that VanderMeer thought that color might interfere with learning because of its impact, or that the color found in his films was not representative of that found in real life. I have another explanation which I relate to the ability of the learner to use verbal cues or labels as substitutes for color. Just as we can handle the concepts of table, chair, or hat by the use of words, so I believe words or labels can be substituted for the actual perception of color by the learner.

There is a rather involved 1966 study conducted by Robert Travers and his associates called "The Effect on Retention of Labeling Visual Displays". The study explored the advantages to be achieved in the retention of information about form or shape which accrues by giving a name to the form or shape. The evidence indicated that when the name served the function of associating some feature of the visual presentation with previous knowledge, retention was improved. The process was described as coding visual information in verbal terms

and by this means linking it up with other previously stored information. In our television study we used printed signs to indicate the color of items, where appropriate. For example, in teaching the value of the meaning of the color coded signs, small signs were used identifying the color of each wire. This was primarily for the benefit of the monochrome viewing group, though both groups saw the signs. It is my belief that the verbal coding or substitution of words for color more than compensated for not seeing the color. I would also guess that this procedure would not work for pre-school children who do not possess sufficient experience with color or language. It is perfectly satisfactory for adult groups.

Implications

What are the implications of these findings with respect to two areas of activity which interest the present audience? Originally, VanderMeer recommended against the use of color in training films because color made no contribution to learning, and color training films cost more. This cost factor need no longer be important. For example, the major Army producer of training films uses 35mm black and white film with a running cost of $46.00 for ten minutes, but can record color on 16mm at a cost of $22.65 per ten minute reel. And this is the current trend today -- to record in 16mm color.

Within the field of television there are some critical factors to be considered in the conversion to, or use of, color television. These major problems are:

A color television facility requires more space for its equipment than does a monochrome facility of the same size. Unless initially planned for eventual conversion to color, most monochrome studio lighting facilities will be inadequate for color in terms of number of lighting fixtures and total electric power. The air conditioning for a color plant requires more stringent control than for a monochrome plant. Although it would be expected that transistor equipment would simplify air conditioning requirements, this is not

the case. Transistors are much more sensitive to temperature changes than are vacuum tubes. They can fail catastrophically under conditions of extreme heat that hardly affect vacuum tube operations. Color television operations and maintenance require better trained technical personnel than an equivalent size monochrome operation. Also, a larger staff may be required.

Finally, the cost of color equipment is higher by an approximate factor of one and one-half to one. For an excellent discussion of the entire problem of converting to color, I recommend an article on this subject by Rosner and Gorchoff in the June, 1967 issue of the *Journal of the SMPTE*.

These, then, are the major reasons restricting the present Army use of color television to medical applications. The fact that color does not appear to provide any learning advantages has become one of the critical reasons for the Army's present position. All this may be swept aside, however, if, in the near future, it becomes apparent that monochrome television equipment will be phased out by manufacturers and it will be no longer possible to obtain new or replacement parts. We have not yet reached that stage.

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